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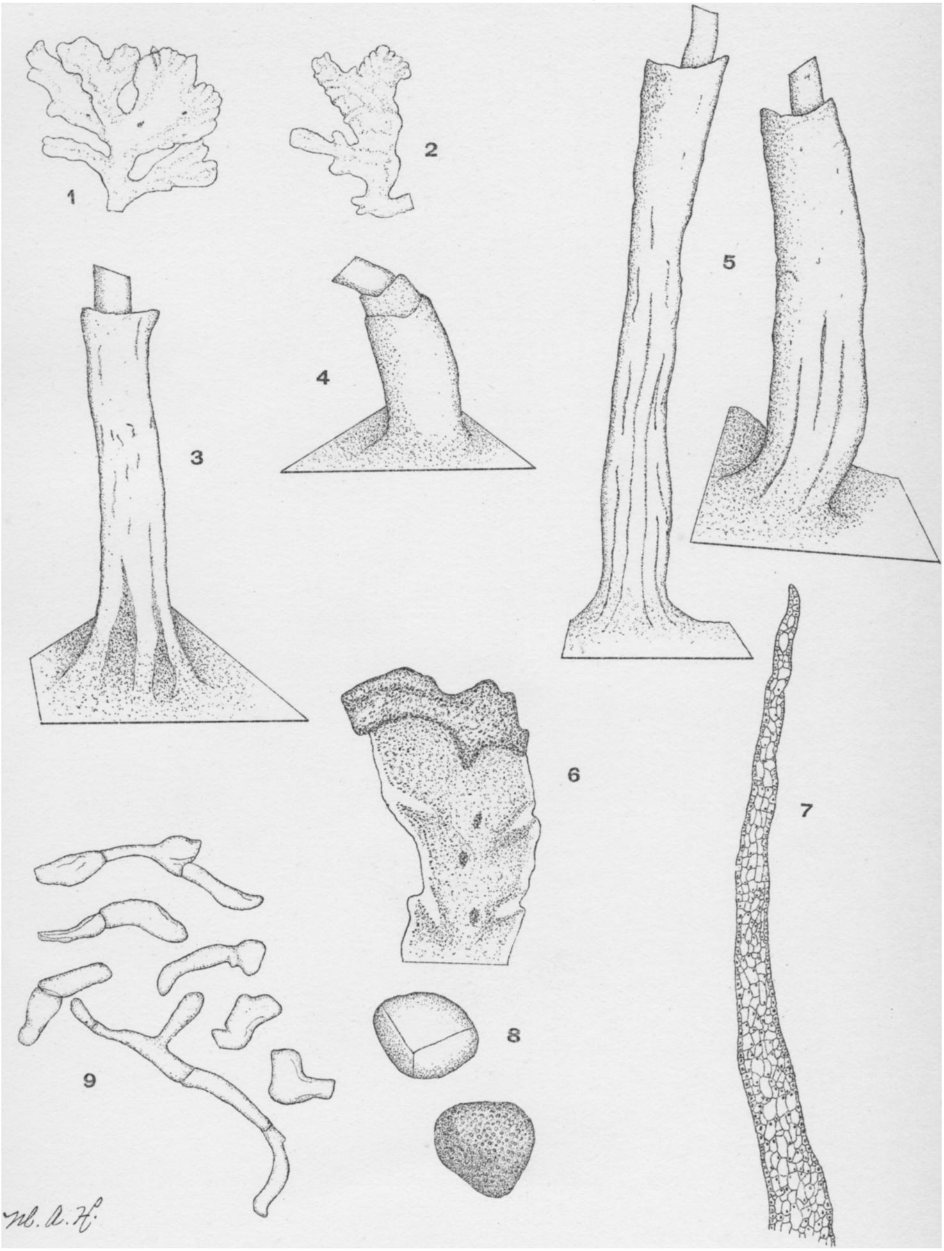
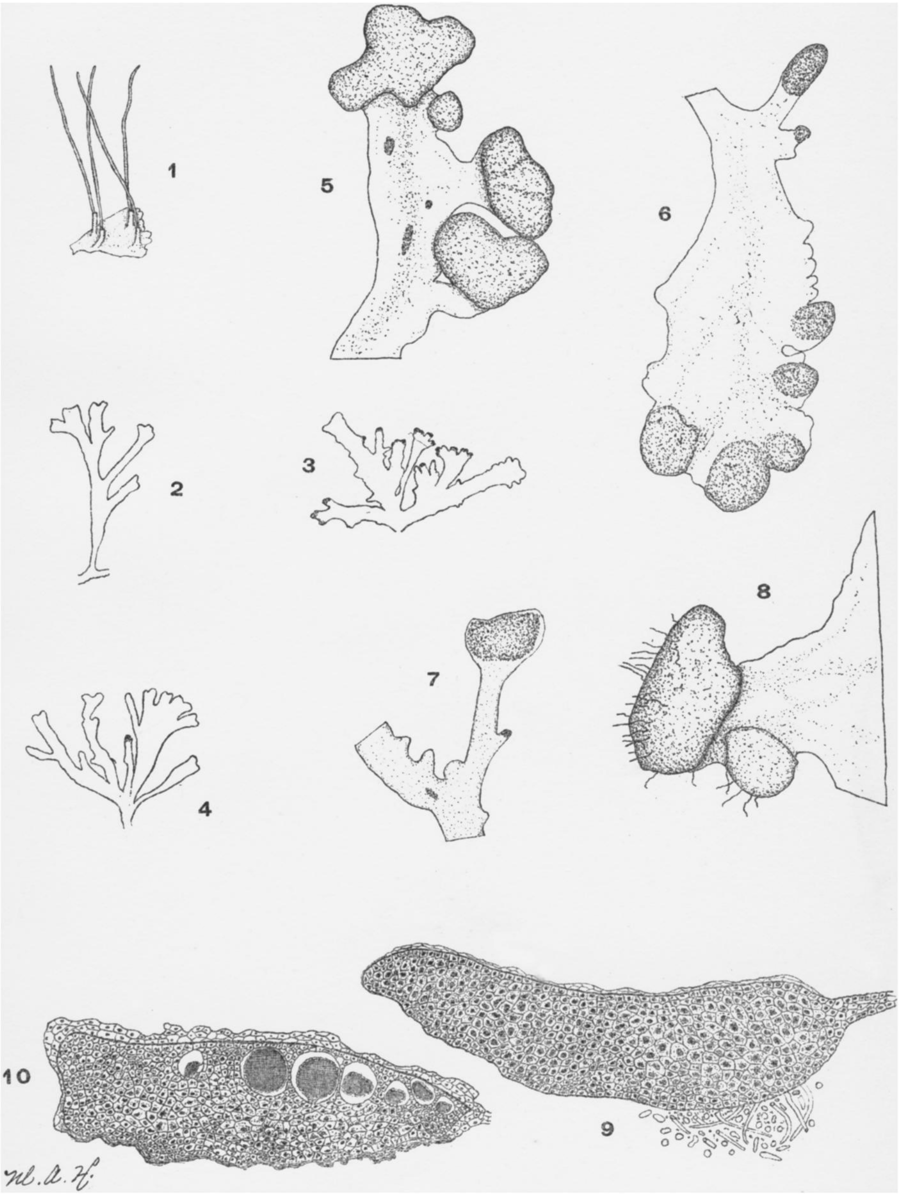


ANTHOCEROS CAROLINIANUS OCCIDENTALIS M. A. HOWE.

THE HELIOTYPE PRINTING CO. BOSTON



ANTHOCEROS PEARSONI M. A. HOWE.

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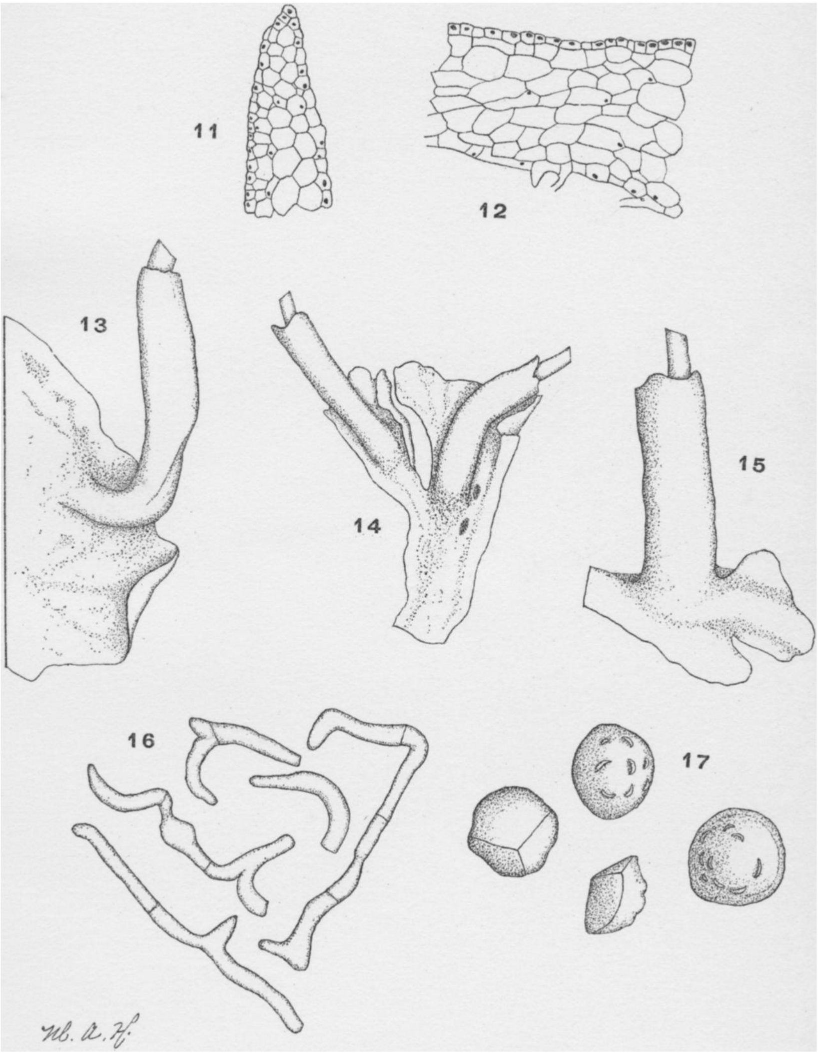

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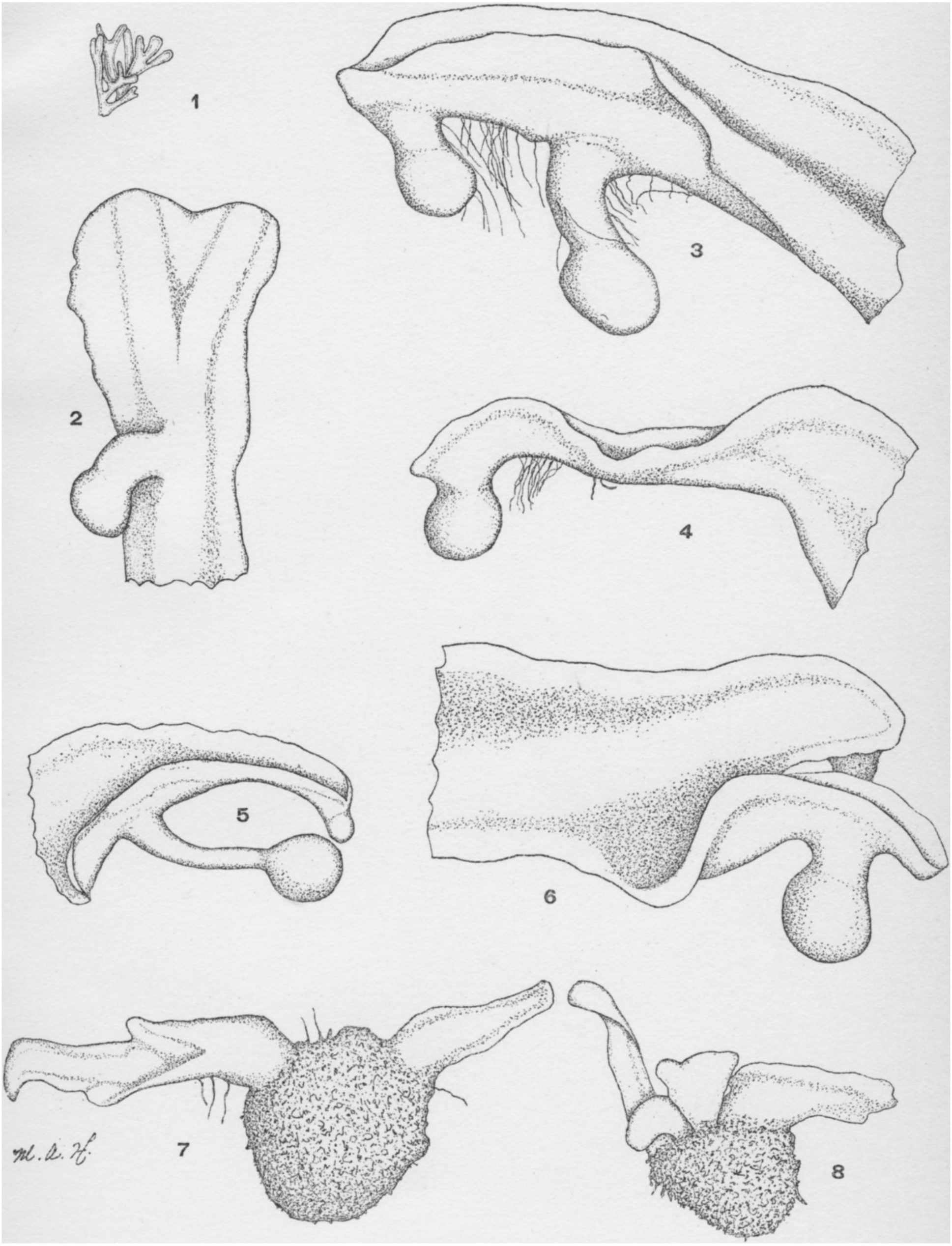

ANTHOCEROS PHYMATODES M. A. HOWE.

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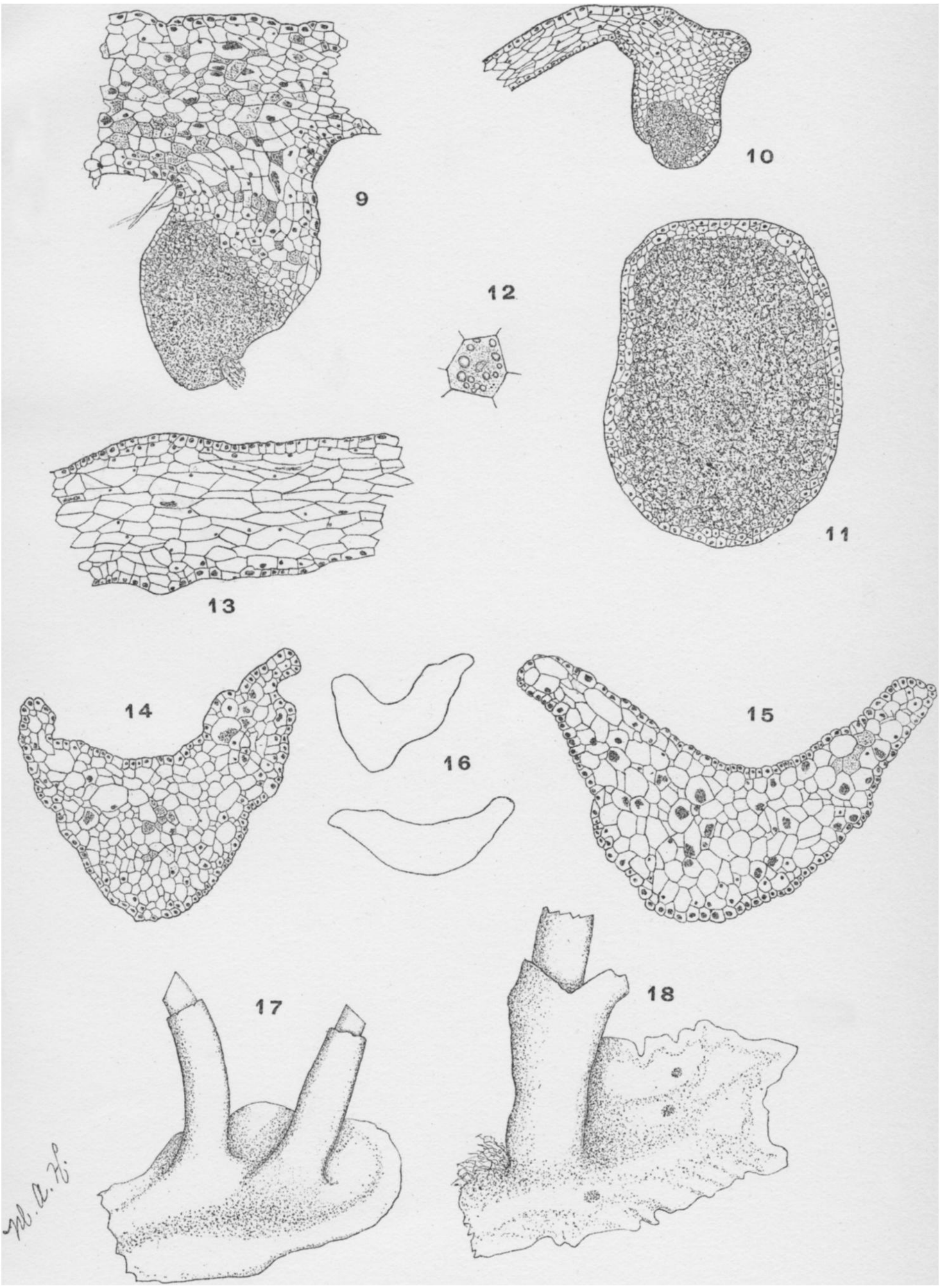

9-17. ANTHOCEROS PHYMATODES M. A. HOWE.
18. ANTHOCEROS POLYMORPHUS RADDI, γ DICHOTOMUS RADDI.

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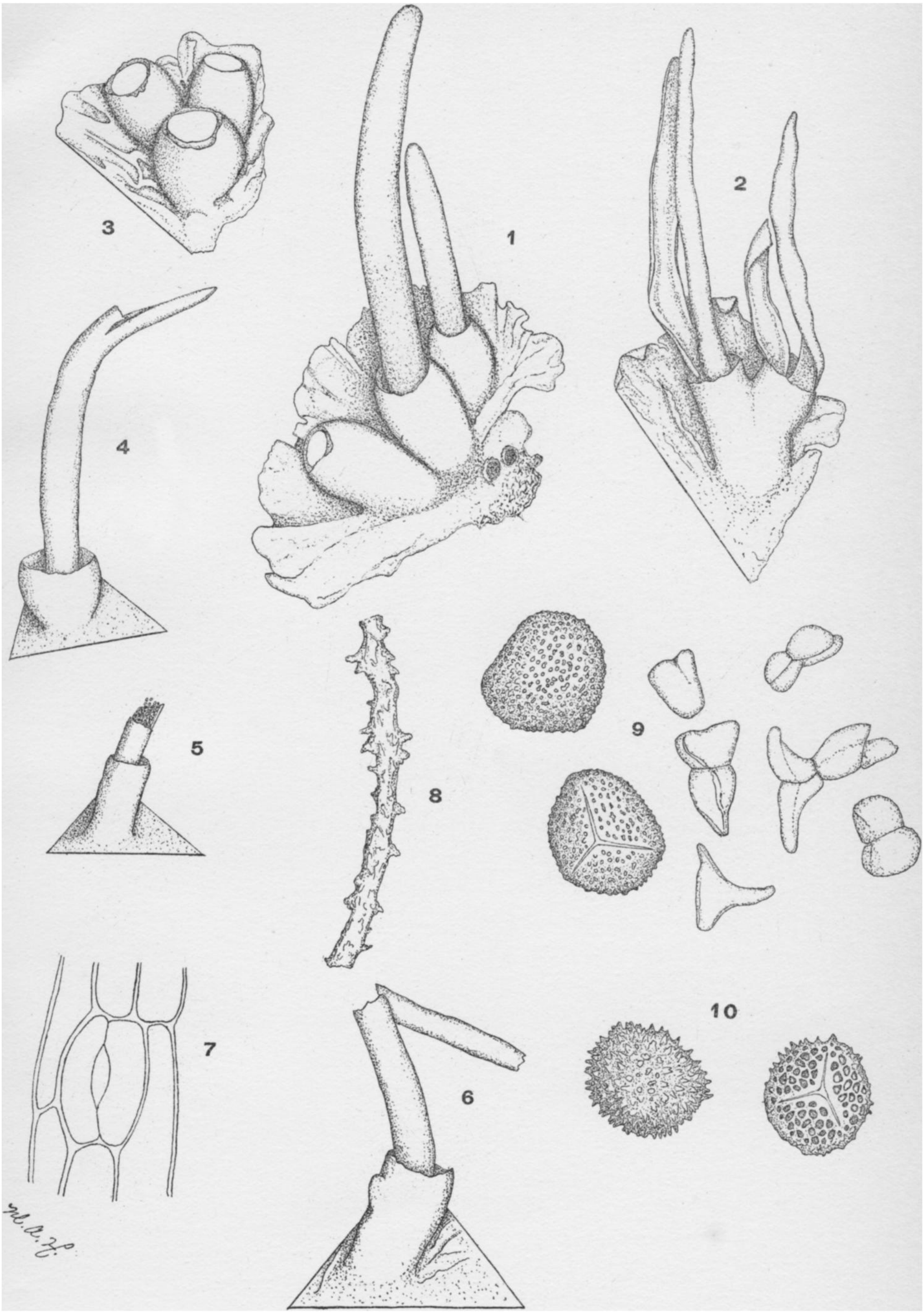

1–9. ANTHOCEROS MACOUNII M. A. HOWE.
10. ANTHOCEROS PUNCTATUS L.

THE HELIOTYPE PRINTING CO. BOSTON

VOL 25 No. 1

BULLETIN
OF THE
TORREY BOTANICAL CLUB

JANUARY 1898

The Anthocerotaceae of North America.

BY MARSHALL A. HOWE.

(PLATES 321–326.)

Important contributions to our knowledge of the North American Anthocerotaceae have been made by Schweinitz,* Sullivant,† Mottier,‡ and Campbell,§ but the principal paper on the subject from the systematic point of view, is that published by Mr. Coe F. Austin in the BULLETIN OF THE TORREY BOTANICAL CLUB, for April, 1875 (6: 25–29), under the title, "Notes on the Anthocerotaceae of North America, with Descriptions of Several New Species." Nine new species were proposed in Mr. Austin's paper, some of them, however, provisionally—"introduced, along with others, for the purpose of calling the attention of collectors more directly to this most obscure family of the Hepaticae." Elsewhere three ad-

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* Schweinitz, L. D. Specimen Florae Americae Septentrionalis Cryptogamicae; sistens Muscos Hepaticos huc usque in Am. Sept. observatos. 8vo, pp. 27. Raleigh, 1821.

On two remarkable Hepatic Mosses found in North Carolina. Jour. Philad. Acad. Nat. Sci. 2: 361–370, 1 pl., 1822.

† Sullivant, W. S. Musci Alleghanienses [Exsicc.] 1845. Id. [Reprint of tickets.] 8vo, pp. 87. Columbus: 1846.

Contributions to the Bryology and Hepaticology of North America. Part I Mem. Amer. Acad., new ser. 3: 57–66. *pl. 1–5.* 1846.

‡ Mottier, D. M. Contributions to the Life-History of Notothylas. Annals of Botany. 8: 391–402. *pl. 20 and 21.* 1894.

§ Campbell, D. H. The Structure and Development of the Mosses and Ferns. 8vo, pp. 544. London and New York: 1895.

[Issued January 25.]

ditional species have been proposed by Austin. It will thus be readily understood that for any adequate review of the North American species of this order, access to the herbarium of Mr. Austin is a necessity. But, unfortunately, after the death of Mr. Austin, his collection of Hepaticae was allowed to leave America, having been purchased by Dr. Carrington and Mr. Pearson, of England, between whom it was divided, Dr. Carrington's portion going finally to the Owens College of Manchester. The inconvenience to American students, of having the Austin collection on the other side of the Atlantic is, however, largely compensated for by the ready liberality of Mr. Pearson, and also of Professor Weiss of the Owens College. Through the kindness of these gentlemen in sending whatever was asked for, we have been able to examine everything of importance in the Austin collection of Anthocerotaceae, including the originals of all his species with the exception of *Anthoceros Joorii*, which is probably of little moment, as it was finally reduced to *A. Ravenelii* by Austin himself. We are also much indebted to Professor Romauldo Pirotta, of the University of Rome, for generously sending for examination the scanty fragments of *Anthoceros caespiticius* De Not., from the De Notaris herbarium—all that is certainly known to exist of this obscure species; to Professor Massalongo for specimens of *Anthoceros dichotomus* Raddi from the Raddian herbarium; to the Philadelphia Academy of Natural Sciences for the loan of the Schweinitz collection; to Dr. B. L. Robinson for the privilege of examining *Anthoceros tuberosus* Tayl., from the Taylor herbarium; and to Herr Stephani, Dr. Evans, Professor Macoun, and Rev. C. H. Demetrio for various specimens. Outside of the specimens named, the present revision is founded on the herbarium of Professor Underwood, the collections of the writer in California, and the herbarium of Columbia University. To Professor Underwood, who has facilitated the work in all possible ways, our thanks are especially due.

ANTHOCEROTACEAE.

Gametophyte a wholly leafless thallus, commonly flat, orbicular, or semiorbicular, more or less lobed or radiately dissected, sometimes subpinnate (*Dendroceros*), or ribbon-shaped and subdichotomously branched, with, or more frequently without, a well-defined costa, usually of several layers of cells, often with interior mucilage cavities, more rarely with intercellular air-spaces, without proper epidermis, but provided on the ventral surface, sometimes also on the dorsal, with inconspicuous clefts (" stomata," " mucilage-slits "), the thallus becoming through these infected with *Nostoc* colonies; cells with a single large chloroplast commonly enclosing the nucleus.

Sexual organs embedded in the thallus; antheridia arising endogenously, short-stalked, single or in groups of 2–4 (rarely more), occupying cavities separated from the dorsal surface by two layers of cells, the covering ruptured at maturity; walls of archegonium confluent with surrounding cells of the thallus, the neck-canal communicating with dorsal surface at maturity of the egg-cell. Special calyptra not differentiated. " Involucre " tubular, of several layers of cells, formed from archegonium-wall and adjacent cells of thallus, usually soon broken through at the apex by the elongating capsule and remaining as a sheath about its base, or (in *Notothylas*) irregularly torn by external agencies.

Sporogonium consisting of a pod-like, usually erect and much elongated capsule, a bulbous foot, and a short intervening zone occupied by a long-active meristematic tissue; capsule dehiscing, with rare exceptions, from the apex downward by two valves, its walls containing chlorophyl and in most species of *Anthoceros* bearing stomata, each with two crescentic guard-cells; a slender thread-like columella, surrounded throughout and covered at the apex by the spore-forming layer, probably always present, but sometimes early disintegrated and obscure. Spores more or less plainly tetrahedral, long adhering in fours, smooth, verrucose, papillate, or echinulate, ripening successively from apex of capsule downward; sterile cells from the archesporium single and subcubical at maturity, or, more often, elongated and forming heteromorphic, variously contorted, occasionally branched filaments of 2–4 cells, sometimes (*Anthoceros* sp. and *Dendroceros*—in tropics and southern hemisphere) with one or more well developed spiral bands, or, more commonly (pseudo-elaters), with spiral thickenings rudimentary or wanting.

Three genera, *Anthoceros*, *Dendroceros*, and *Notothylas*, are ordinarily recognized, the second of which is not known to occur within our limits.

ANTHOCEROS L. Sp. Pl. 2: 1139. 1753. Ex Mich. Gen. Pl. 10, *pl. 7, f. 1, 2.* 1729.

Thallus suborbicular, variously lobed or irregularly dissected, now and then somewhat ribbon-shaped and subdichotomous, of more than one layer of cells throughout, costa wanting, indistinct, or rarely prominent; monoicous, proterandrous, or sometimes dioicous (?)[*]; capsule erect, bivalved, much exceeding the involucre in length, usually very long, with stomata (in the North American species). Spores granulose-papillate, tuberculate, or echinulate, rarely nearly smooth; sterile cells (in all our species) without spiral thickenings.

Key to the Species.

- Spores yellow.
  - Thallus with peduncled tubers from ventral surface.
    - Thallus opaque; tubers few (1–3 to a segment), .25–1 mm. in diam., on peduncles .1–.4 mm. thick. 5. *A. phymatodes.*[†]
    - Thallus pellucid; tubers numerous, .15–.3 mm. in diam., on peduncles .08–.09 mm. thick. 6. *A. Donnellii.*
  - Thallus without ventral peduncled tubers.
    - Capsule 3–6 mm. long; pseudo-elaters mostly of single cells, often as broad as long. 4. *A. Hallii.*
    - Capsule 6–50 mm. long; pseudo-elaters mostly of 2–4 elongated (2–10:1) cells.
      - Spores with a few (8–15) crescentic verrucae on convex (outer) surface, or nearly smooth; thallus usually with marginal, sometimes peduncled, glandular-thickenings. 3. *A. Pearsoni.*
      - Spores thickly granulose-papillate.
        - Involucres .8–2.5 mm. high, usually expanded at mouth; major segments of thallus 4–15 mm. long. 1. *A. laevis.*
        - Involucres 2–6.5 mm. high, scarcely or not at all expanded at mouth; major segments of thallus 8–30 mm. long. 2. *A. Carolinianus.*

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[*] Certain species of *Anthoceros* have been described as dioicous, yet in a genus of which the best known representatives are proterandrous, and in which the archegonia are observed with so much difficulty, it may be suspected that careful investigation, by modern methods, would show proterandry to obtain in all.

[†] Mature spores of *A. phymatodes* are unknown, but the close affinity of this species with *A. dichotomus* of southern Europe makes it nearly certain that it belongs in the yellow-spored series.

Spores fuscous or black.
  Pseudo-elaters mostly of 1–4 elongated (2–10:1) cells.
    Pseudo-elaters 12–18 μ in width; spores 35–58 μ in maximum diameter, the outer face with numerous (75–125) spines or papillae 3 μ or more in length; involucre 1–5 mm. high. 7. *A. punctatus.*
    Pseudo-elaters 8–14 μ in width; spores 45–63 μ in maximum diameter, the outer face with very numerous (125–225) spines or papillae less than 3 μ in length (or sometimes longer in var. *stomatifer*); involucre 2–9 mm. high (Pacific coast). 8. *A. fusiformis.*
  Pseudo-elaters mostly of single cells about as broad as long, these sometimes in catenulate groups or variously adherent, or fragmentary and inconspicuous.
    Spores 70–100 μ in maximum diameter, scarcely angled; capsule 8–20 mm. long. 9. *A. Ravenelii.*
    Spores 48–65 μ in maximum diameter, rounded-tetrahedral; capsule 3–6 mm. long. 10. *A. Macounii.*

1. ANTHOCEROS LAEVIS L. Sp. Pl. 2: 1139. 1753.

Anthoceros Oreganus Aust. Bull. Torr. Bot. Club, 6: 26. 1875.
Anthoceros Mohrii Aust. Bull. Torr. Bot. Club, 6: 304. 1879.

Thallus nearly smooth and flat, rarely with elevate-crispate margins, dark green, exhibiting a somewhat fatty lustre, subradiately dissected, ecostate; major segments irregularly obovate or obcuneate, 4–15 × 2–5 mm., once or twice subdichotomously cleft, rounded or emarginate at apices, 6–8 cells thick in the middle, becoming gradually 3- or 2-stratose toward the very rarely glandular-thickened margin; surface-cells mostly indistinct after drying, subrhombic to long-hexagonal, 30–105 × 24–40 μ, the inner cells much larger, hyaline, without evident air- or mucilage-cavities: monoicous (polyoicous?): involucres sometimes in pairs, cylindrical, commonly rather slender, at maturity usually more or less widened above and trumpet-shaped, .8–2.5 × .4–1.3 mm., the mouth entire, repand or sublobate, sometimes plicate, rarely scarious: capsule 10–35 (mostly 20–25) × .25–.42 mm., light brown, with a very short pedicel, the valves often much twisted; spores yellow, thickly granulose-papillate, especially on the convex (outer) face, 35–56 μ in maximum diameter; pseudo-elaters nearly colorless to light yellowish-brown, of 1–4 cells, geniculate, often branched, the cells extremely variable in size and form.

Exsicc. Drumm. Musc. Am. (So. States) 1841, no. 154 (as *A. punctatus*); Hep. Bor-Am. 123; Hep. Am. 4.

On moist ground, wet rocks, banks of rivulets and of roads. Not uncommon throughout the United States, with the exception of the Rocky Mountain region and the Pacific coast, where it is apparently rare. Canada (*fide* Austin). Specimens from New Orleans (Drumm. Musc. Am.—So. States—no. 154), White Plains, N. Y. (L. M. Underwood, Sept. 28, 1896,) and Muscatine, Iowa (B. Shimek, October, 1896), differ from the ordinary form in having the margins of the thallus here and there glandular-thickened and the surface cells rather more distinct.

Anthoceros Oreganus Aust. is known outside of the description only from a small and unsatisfactory specimen in the Austin collection, which may be fairly presumed to be the original. The packet bears on the outside the inscription in pencil "*Anthoceros* ——? Rocky Mts., Hall," and just above the dash "*Oreganus*" has been supplied later in ink, all evidently in Austin's handwriting. Inside the packet is a slip of manilla paper on which is written "24, moist earth, Oregon," in pencil by another hand, probably Hall's. The involucres in this specimen are rather short and 1–1.7 × .4–.65 mm., often somewhat widened at the mouth, but not especially constricted above the middle as described by Austin. The thallus is in a poor state of preservation. The spores in size, color and markings seem identical with those of the European *A. laevis* and we see no sufficient reason for separating it from this species. The thallus doubtless has glandular-thickenings like the forms alluded to above.

Anthoceros Mohrii Aust. was studied in the field by Austin, and was pronounced* by him distinct from *A. laevis*, but it may be inferred from his remarks that the comparisons may have been made wholly with *A. laevis* var. *major* Aust. (*A. Carolinianus* Michx.). The spores in the original specimen we find to be a little larger than in the typical *A. laevis* instead of smaller as described by Austin. They are, it is true, rather more coarsely and closely granulate-papillate than in the ordinary forms of *A. laevis*, yet the differences in this respect can hardly be defined with precision, and certain specimens of *Anthoceros laevis* from other localities show that this character cannot be depended upon. The thallus is lightly lacunose with rarely a suggestion of a lamella-like ridge. The tubers referred to by Mr. Austin were probably, for the most part, *Nostoc* colonies, which were not recognized by him in their true character in any of his descriptions of Anthocerotaceae. The view that the "tubers" were here mostly *Nostoc* colonies is supported by examination of a detached fragment enclosed in a small separate wrapper in the pocket containing the type material (Herb. Pearson). This scrap of the thallus contains several conspicuous protuberant globose *Nostoc* masses, but nothing in the nature of true tuberous thickening. In other portions of the type specimen, however, somewhat rounded glandular-thickenings, furnished beneath with root-hairs, occur, though rarely.

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* Bull. Torr. Bot. Club, 6: 304. 1879.

2. ANTHOCEROS CAROLINIANUS Michx. Fl. Bor-Am. 2: 280. 1803.

Anthoceros laciniatus Schwein. Spec. Fl. Am. Sept. Crypt. 25. 1821.

Anthoceros laevis tenuis Nees (*p. p.*) Naturg. Eur. Leberm. 4: 330. 1838.

Anthoceros laevis major Aust. Hep. Bor-Am. no. 123^b. 1873.

Thallus large, thin, ecostate, nearly smooth, prostrate, the margin often undulate-crisped and ascending, sometimes crowded and subcaespitose, light- or dark-green, a little pellucid or, on drying, opaque with a somewhat fatty lustre, dissected; major segments oblong or obovate, 1–3 times subdichotomously branched, 8–30 × 2–7 mm., more or less widened at the rounded crenate apex, 4–8 cells thick in the middle, passing gradually into a wide 3- or 2-stratose margin, or nearly uniform throughout; surface-cells distinct in terrestrial forms, obscure in the aquatic, irregularly rhombic, becoming elongate-hexagonal, 20–120 × 18–30 μ: monoicous: involucres sometimes united in pairs, thick-walled, somewhat pellucid, long-cylindrical, 2–5 × .5–1.1 mm., sometimes contracted or now a little widened toward the thin, subentire or repand-dentate, rarely scarious mouth, often longitudinally plicate toward the base: capsule slender, 25–50 × .25–.5 mm., pale brown, short-pedicellate, the valves twisted; spores and elaters as in *A. laevis.*

EXSICC. Hep. Bor-Am. 123^b; Hep. Am. 164.

On wet, gravelly ground and beside brooks, often nearly or wholly submerged. Found especially in the Southern States. Florida (Torrey, Austin, J. D. Smith, Underwood, Lighthipe, F. C. Straub); Georgia (Lesquereux); South Carolina (Ravenel); North Carolina (Schweinitz). What was undoubtedly this species came into the hands of Dillenius from Virginia, where it was collected by Mitchell. Sterile plants in the Austin collection from Closter, N. J. (Austin), and New Haven, Conn. (D. C. Eaton), seem also to belong here.

A. Carolinianus differs from *A. laevis* chiefly in greater size of the thallus, in the longer involucres, scarcely expanded, sometimes contracted, at the mouth, and in the (typically) more slender capsules. The species as a whole is perhaps to be looked upon as an aquatic or semi-aquatic analogue of *A. laevis*, from which it is probably not always distinct. It, however, departs so widely from the ordinary conception of *Anthoceros laevis* and is usually so easily recognizable that we think it has a fair claim to specific recognition. Schweinitz' plant (*A. laciniatus*) has oblong or almost linear segments. The original of Michaux is not found, we are informed, in his collections, now preserved at Paris.

ANTHOCEROS CAROLINIANUS OCCIDENTALIS var. nov.

Thallus usually densely caespitose, ascending, now and then with margins and lobes glandular thickened; involucres sometimes longer, 2–6.5 × .5–1 mm.; capsule less slender. (Plate 321.)

On wet rocks and on the banks of rivulets near the water-line. California (Underwood, Parish, McClatchie, Setchell, Jepson, Koch, Howe).

As the type of var. *occidentalis* we select a specimen collected by Mr. W. L. Jepson, near Olema, Marin county, California, April 1, 1893. This formed, when growing, wide cushions 3–4 cm. in depth; the margins of the frond are here but slightly or not at all glandular-thickened. In drying, the thallus is not infrequently much blackened. In the glandular-thickened forms, involucres which seem abnormally shortened and incrassate (2–2.5 × 1 mm.) are often found intermingled with the longer. Such involucres commonly have scarious mouths.

3. ANTHOCEROS PEARSONI sp. nov.

Thallus smooth, prostrate or ascending, rarely erect, mostly irregularly dissected; the major segments linear or elongate-flabelliform, 5–20 × 1–5 mm., often intertangled, sparingly lobed or two or three times subradiately dichotomous, plane or slightly concave, rarely costate ventrally at apices, in sterile plants usually 6–11 cells thick, gradually or abruptly reduced to three or four at the margin, in the fertile commonly expanded into a wide 3- or 2-stratose lamina with a lightly crisped periphery, the lobes in both often terminating in dark green, globose or difform, glandular-thickenings, .2–2 mm. in diameter, these sometimes long-peduncled, rarely descending and radiculose; surface-cells rather distinct, rhombic-trapezoidal to oblong, 20–70 × 20–30 μ, the inner larger but compact; *Nostoc* colonies usually abundant, ellipsoidal or fusiform: monoicous: involucres solitary or approximate in pairs, subterminal in erect forms, somewhat pellucid, mostly light green, elongate-cylindrical, 2.3–3.3×.5–.85 mm., sometimes decumbent at base, the mouth entire, repand-dentate, often lacerate with age, now and then scarious: capsule pale brown, yellowish, or drab, slender, sulcate, 8–32 (mostly 20–24) × .24–.4 mm., rather thick-walled, the valves finally thin and often twisted, stomata abundant; columella filiform, naked; spores yellow, the convex face with a few (8–15) small, crescentic, rarely obsolete warts, otherwise smooth or most faintly granulose, 35–50 μ in maximum diameter; pseudo-elaters dilute yellow or occasionally tinged with brown, of 1–4 cells, geniculate and variously contorted, often branched, the cells 30–80 × 6–10 μ, with wall of nearly uniform thickness. (Plates 322 and 323.)

Exsicc. Hep. Am. 161 (as *A. laevis*).

On moist banks and dripping rocks. California (Bolander, Parish, Brandegee, Howe, Campbell, Hasse); Washington (Piper).

The commonest yellow-spored *Anthoceros* of California, and perhaps of the Pacific coast as a whole. We have seen as many as twenty specimens, ranging from southern California to Washington, and they are always very clearly distinct from *Anthoceros laevis*, *A. Carolinianus*, and *A. Hallii*; differing from the last-mentioned in having the capsule usually four times as long, in the much more perfect pseudo-elaters, composed of 1–4 elongated cells, in the spores being scarcely otherwise roughened than by 8–15 small crescentic verrucae, etc.; very different from both *A. laevis* and *A. Carolinianus*, in the character of the spore-markings, the spores of the two latter species being always thickly granulose-papillate. Sterile conditions can sometimes be only doubtfully distinguished from *A. Hallii*, but can be separated from glandular-thickened forms of *A. Carolinianus occidentalis* by the narrower segments and often peduncled glands. The species is extremely variable in thickness and form of thallus, though very constant in spore-markings. In its thicker, slightly costate conditions, particularly when the glandular-thickenings are long-stalked, descending, and tuber-like, the thallus bears some resemblance to that of *A. phymatodes*, but in all such cases, we believe, the attachment of the tubers never becomes strictly ventral; their peduncles can, with care, always be traced back to the margins of the frond. The glands or tubers are 10–25 cells in thickness and consist of a more or less distinctly defined capsule of 1–3 layers of undifferentiated cells enclosing cells containing at first an unusually large chloroplast and later filled with oil-drops or densely crowded with whitish granules. These organs are evidently food reservoirs, adapting the thallus to persistence through the dry summers of the region that the plant inhabits. In the neighborhood of San Francisco the thickenings begin to appear in January or February, attaining full development in May or June. In our no. 702, collected near Mendocino, California, these marginal thickenings often enclose numerous antheridia.

We take pleasure in dedicating this clearly marked species to Mr. W. H. Pearson, of Knutsford, Cheshire, England, whose careful work on the Hepaticae of Canada and of various other parts of the world is well known, and whose liberality in loaning the Austin collection of *Anthoceros* has been an important and much appreciated aid in the preparation of this paper.

The above description of *Anthoceros Pearsoni* is based upon various specimens, but our no. 16, collected at Mill Valley, Marin County, California, May 7, 1892, from which the figures of the spores, pseudo-elaters and capsules have been drawn, we consider the type of the species.

4. ANTHOCEROS HALLII Aust. Bull. Torr. Bot. Club, **6**: 26. 1875.

Anthoceros sulcatus Aust. *l. c.* 27.

Thallus caespitose, erect, more rarely prostrate-entangled, dark green or often extensively etiolated, sometimes indistinctly plicate-costate; the major segments attenuate at the base, flabelliform, or somewhat linear in the prostrate forms, 5–10 mm. long, 3–5 mm. broad above, sometimes once or twice subdichotomously cleft, crenate-lobed or repand at apical margins, 6–8 cells thick along the middle, otherwise 4–2-stratose, the lobes often terminating in irregular yellowish-brown or olive-green, glandular thickenings, .3–2 mm. broad, these sometimes descending and tuber-like; surface-cells quadrate-oblong to irregularly rhombic-pentagonal, 35–60 × 25–30μ; *Nostoc* colonies conspicuous, globose or fusiform: monoicous: antheridia usually in pairs: sporogonia very numerous; involucres from just below the apex of the thallus, in groups of 2–5 but distinct at base, obovate-quadrate to oblong-cylindrical, 1–2.3 × .5–.72 mm., repand-dentate or sometimes irregularly lacerate at mouth: capsule dull straw-colored, erect or a little curved, 3.3–6 (mostly 4–4.5) × .32–.56 mm., sulcate and compressed-quadrangular when dry, with acute or slightly winged angles, usually rather abruptly contracted below to a short pedicel, thick-walled, crowded with spores at maturity, marked with a narrow yellow suture on either side but long indehiscent, stomata large, the guard-cells yellowish; columella very slender and inconspicuous; spores yellow, the convex face with 20–35 wart-like papillae, the other faces faintly punctate near the middle, 44–58 μ in maximum diameter; pseudo-elaters of short, irregular, mostly unicellular fragments, often as broad as long, the walls unequally thickened.

EXSICC. Hep. Am. 162.

"On moist earth" and "in wet meadows." Silverton and Salem, Oregon (E. Hall); Seattle, Washington (C. V. Piper).

The fertile plant from Silverton (E. Hall, no. 26), which is first cited after Austin's diagnosis, should undoubtedly be considered the type of the species. This is preserved both in Herb. Pearson and in the Herbarium of the Owens College of Manchester, England. Its capsules are rather immature, as observed by Mr. Austin, but it is clearly the same specifically as *Anthoceros sulcatus* Aust., the original of which is represented by good specimens, under Austin's manuscript name, *Notothylas Hallii*, in both the herbaria named above. It is quite probable that the sterile plants from Oregon, also placed with *A. Hallii* by Austin and from which the original description was, doubtless, in part drawn, belong with *Anthoceros Pearsoni*, which has a somewhat larger thallus and a wholly different sporophyte, though in the absence of the latter phase it would perhaps be rash to assume to identify them positively. *Anthoceros Hallii* is very distinct—in the fertile condition, at least—from any of the other American Anthocerotaceæ.

The mature capsules are filled with ripened spores far below the mouth of the involucre, yet in only a few cases have we seen indications of dehiscence, which takes place—rather imperfectly, it may be—between two rows of narrow, yellow, thick-walled cells. Some of the dark algal colonies in the thallus are composed of detached cells 10–15 μ in diameter, consisting of a spherical, highly refractive centre surrounded by a thick, shriveled membrane. These appear to be resting spores derived from delicate inconspicuous filaments belonging to the Nostochineae, but possibly not identical with the *Nostoc* that most abounds in the thallus of the species. Black spherical masses 30–45 μ in diameter, belonging to a parasitic fungus, occur somewhat sparingly in the thallus and may be what Austin referred to as "black, tuber-like gemmae." The fungus is described in more detail in our remarks upon *Anthoceros Ravenelii.*

5. ANTHOCEROS PHYMATODES sp. nov.

Thallus dark green, blackening on drying, dissected; the segments dichotomous, oblong or linear in sterile plants, broader in the fertile, 4–10×.5–2.5 mm., prostrate or very slightly ascending at the apices, at first radiate, becoming later intricately entangled, narrowly canaliculate dorsally, with ascending sinuate or repand margins, obtuse, carinate with a broad thick, very distinct or sometimes obsolescent, naked or sparingly radiculose costa, this occupying nearly the whole of the narrower segments and sending down here and there a fleshy or elongated and slender process (.1–.4 mm. in thickness), terminated by a globose or ellipsoidal tuber, the latter .25–1 mm. in diameter, pale when living, yellowish-brown on drying, becoming finally closely covered with root-hairs; thallus 10–16 cells thick in region of costa, passing gradually or rather abruptly into the more or less extended 5–3-stratose marginal lamina; surface-cells rhombic to rhombic-oblong, 33–66 × 20–33 μ, indistinct after drying: involucres separate, cylindrical, 1.7–2 × .5 mm., smooth, truncate, entire or slightly repand at the mouth. (Plates 324 and 325.)

On compact soil in a nearly level open plot about fifty feet north of "The Old Mill," Mill Valley, Marin Co., California (Howe: Mar. 19, 1892, and Feb. 22, 1896; the latter, which bears the involucres, we consider the type). Also collected by Dr. Bolander at "Oakland, on slides near the bay." The few capsules that have been seen are very immature, projecting only about 1 mm. beyond the mouth of the involucre, and it is quite possible that the description of the involucre given above will need some modification on the discovery of fully ripened sporogonia.

It is practically certain that this species is, in part, at least, what Austin referred provisionally to *Anthoceros caespiticius* De Not. (Bull. Torr. Bot. Club, **6**: 26 1875), drawing his description, however, "from a specimen in Herb. Torrey under the name *A. laevis* Linn., from the Island of Corsica." We had thought to take up for *A. phymatodes* the specific name *Torreyi* Aust. MS., which appears in parenthesis after *A. caespiticius* in the place cited, but an examination of the Austin collection, so generously loaned by Mr. Pearson, showed the manuscript diagnosis of *A. Torreyi* affixed to a scrap of the Corsican plant (which we refer to *Anthoceros dichotomus* Raddi) and that plant alone alluded to at the close of the description. *A. Torreyi* Aust. MS. is therefore a synonym of *A. dichotomus* and not of *A. phymatodes*. Bolander's specimen is accompanied by a slip of brown paper on which is written—evidently by himself—" Oakland on slides near the bay," but it is found in the Austin collection glued to Austin's manuscript description of *A. Lescurii* from New Orleans, the evident type of which appears in the same collection under the name of *A. Ludovicianus*.

Anthoceros phymatodes is a near ally of *A. dichotomus* Raddi, specimens of which from Raddi's herbarium we have had the privilege of examining through the kindness of Professor Massalongo, as well as specimens from Portugal and Italy, obligingly communicated by Herr Stephani. But *A. dichotomus* has a costa 1/8–1/3 the width of the segment, 6–10 cells thick, the lamina mostly 2-stratose, involucre .7–1 mm. wide, often enlarged at the irregularly 2–4-lobed mouth ; while *A. phymatodes* has a costa $\frac{1}{3}$–$\frac{3}{3}$ the width of the segment, 10–16 cells thick, the marginal lamina 5–3-stratose, involucre .5–.6 mm. wide, not expanded at the entire or repand mouth. To facilitate further comparison, when the mature sporogonia are found, it may be added that in *A. dichotomus* from Raddi's herbarium (" *Anthoceros polymorphus* Raddi γ *dichotomus* Raddi" is the legend the packet bears) the capsules are erect or slightly curved, 7.5–15 mm. long, often thickened toward the apex, spores yellow, becoming yellowish-brown, rounded-tetrahedral, almost wholly smooth on all faces, 42–60 μ in maximum diameter, pseudo-elaters yellowish, of 1–4 irregular elongated cells, geniculate, variously contorted, often branched.

Anthoceros caespticius DeNot, the probable original of which (from the vicinity of Cagliari, in southern Sardinia), we have been allowed to study through the indulgence of Professor Pirotta, is not closely related to *A. dichotomus*, with which it was compared by its author. It is a near ally of *Anthoceros punctatus* and may not be specifically distinct. The spores incline to be fuscous and are finely setose-papillate on the outer face and foveolate-reticulate on the inner faces; they are 40–45 μ in maximum diameter. The pseudo-elaters are practically as in *A. punctatus*. The involucres measure .65–1.1 × .25–.5 mm. It is surely very different from the Californian plant, even though mature spores of the latter are wanting. The thallus apparently bears no tubers; it is thinner than in *A. phymatodes*, is quite indistinctly costate, and has the peculiar narrow ascending marginal shoots of *A. punctatus*. It is described by DeNotaris as being erect, while *A. phymatodes* is prostrate.

Anthoceros tuberosus Tayl., from Swan River, Australia (Drummond, 1873), we have examined through the courtesy of Dr. B. L. Robinson, Curator of the Gray Herbarium, in which the Taylor collection is incorporated. It differs from our plant in the much thinner, broader, scarcely costate thallus, the terminal or marginal tubers, and the shorter somewhat obovate involucres. The spores are yellow, becoming brownish, sparingly warty-granulose, 35–45 μ; pseudo-elaters mostly of 1 or 2 elongated geniculate cells.

Anthoceros phymatodes differs from *A. Donnellii* Aust. in the larger, less numerous tubers on stouter stalks, as indicated more definitely in our descriptions and in the key to the species, also in the thicker, more opaque thallus, with less distinct surface cells, in the longer segments, etc.

The tubers of *A. phymatodes* are formed at the apex of the costa, but their peduncles become strictly ventral in their attachment by the continued onward growth of the segment. Two or three tubers successively older and larger as one passes backward may often be seen depending from a single branch. The tuber consists of a cortex of 2-4 layers of nearly empty cells enclosing a central mass of smaller cells so densely filled with oil drops or whitish granules that the cell boundaries in a section are rendered obscure. The whitish granules in alcoholic material show a starch reaction with iodine.

6. ANTHOCEROS DONNELLII Aust. Bull. Torr. Bot. Club, 6: 304. 1879.

Thallus small, smooth, rather thin, substellately dissected, the segments irregular in form, somewhat overlapping and intertangled, light green, pellucid, broadly and sometimes indistinctly costate, bearing beneath very numerous small, pyriform or subglobose tubers, these .15–.3 mm. in diameter, on slender peduncles .25–.6 × .08–.09 mm.; major segments oblong, obcuneate, or sublinear, 2–8 × 1–2 mm., lightly canaliculate when dry, subcrenate at apex, 5–8 cells thick in middle becoming 3- or rarely 2-stratose at margin; surface-cells very distinct, protuberant, subquadrate-rhombic to oblong-pentagonal, 36–75 × 30–45 μ, the inner cells, especially toward the margin, very large and hyaline: dioicous:* involucre large, infundibuliform, incised at the mouth; capsule, spores and elaters nearly as in *A. laevis.*

"Banks of the Caloosahatchee River, southwest Florida, Mar., 1878; rare" (Austin).

Type in Herb. Pearson; duplicate in Herb. Columbia University and Herb. Underwood. Though we have had the privilege of examining all the material of this species in the three herbaria mentioned, we have found no involucre, and for that can simply copy the description of Austin. A portion of a single capsule was found lying on the thallus, but the organic connection of the two could not be determined, though there was no indication of a mixture with any other species. This bore yellow, granulose-papillate spores, 42–45 μ in maximum diameter, and elaters like those of *A. laevis.* Austin in his notes following the diagnosis describes the spores as "smooth or nearly so," but he also characterized those of *A. laevis* as "nearly smooth."†

A. Donnellii is somewhat allied to *A. dichotomus* and *A. phymatodes,* but evidently differs from both in the pellucid thallus, the very distinct surface-cells, the less elongated segments, in the smaller, more numerous tubers on shorter, narrower peduncles, springing from the region of the costa but often in groups of 3–8 and somewhat laterally distributed, and is probably different also from both in the form of the involucre and from *A. dichotomus* in the thickly granulose-papillate spores.

7. ANTHOCEROS PUNCTATUS L. Sp. Pl. 2: 1139. 1753.

Anthoceros scariosus Aust. Proc. Acad. Nat. Sci. Philad. 230. 1869.

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* The description from this point on is from the Latin of Austin's original diagnosis.

† Bull. Torr. Bot. Club, 6: 25. 1875.

Thallus rosettes rather small, 5–15 mm. in diameter, light green, more or less blackened in drying, depressed, or somewhat erect and turbinate, laciniate and undulate-crisped, often with slender ascending marginal lobes, variously lamellate-ridged, lacunose, or warty, 8–12 cells thick in median parts, becoming rather suddenly 3- or 2-stratose at periphery, sometimes indistinctly costate, here and there usually glandular-thickened with age; surface-cells distinct, protuberant, subquadrate, irregularly pentagonal or hexagonal, 45–75 × 30–45 μ, with a large angular chloroplast, the interior cells much larger, thin-walled, surrounding numerous and ample lacunae: monoicous: involucres often geminate, cylindrical, oblong-linear, 1–5 × .4–1.1 mm., sometimes lamellate, scarious now and then at the repand mouth: capsule dark brown or black, 8–60 (mostly 15–30) × .25–.45 mm., with somewhat elongated pedicel; spores black or nearly so, 35–58 μ in maximum diameter, angular, the convex face furnished with numerous (75–125) spines or 2- or 3-pointed papillae 3 μ or more in length, the plane faces foveolate-reticulate, sometimes becoming granulose-papillate near the angles; pseudo-elaters fuscous, 45–200 × 12–18 μ, of 1–4 cells, geniculate, variously contorted and inflated.

EXSICC. Hep. Bor-Am. 122; Hep. Am. 82.

On damp ground. Less common than *A. laevis*, with which it sometimes grows. Connecticut (Underwood, Evans); New York (Coville, Underwood); Ohio (Lesquereux, Werner); Tennessee (Naylor); South Carolina (Austin); Florida (J. D. Smith, Underwood); Alabama (Mohr); Louisiana (Langlois); Missouri (Demetrio); Canada (*fide* Austin).

The measurements in the above description have been drawn in part from the European *A. punctatus* of authors which is extremely variable and is thought by some to include more than one species. We have seen no American specimens with involucres longer than 4 mm. or capsules longer than 4 cm.

Anthoceros laevis is often confused with *A. punctatus* in herbaria, but the former can always be very easily distinguished from the latter when fertile and mature, by the spores; when sterile—if superficial characters are doubtful—by the absence of lacunae within the thallus, which in *A. punctatus* are large and numerous.

8. ANTHOCEROS FUSIFORMIS Aust. Bull. Torr. Bot. Club, 6: 28. 1875.

Thallus in depressed rosettes 6–20 mm, in diameter, or often suberect and caespitose, in tufts 5–20 mm. deep, thick and rather rigid, opaque and blackened when dry, undulate-crisped, deeply and irregularly dissected, ecostate, cavernose within, 10–25 cells thick in median parts, becoming rather abruptly 3- or 2-stratose at margin, often with large and abundant glandular-thickenings, more or less lamellate-cristate, lacunose, the lamellae sometimes broad and leaf-like; surface-cells somewhat distinct, subquadrate to oblong-hexagonal, 30–75 × 18–40 μ, with large chloroplast, inner cells much broader and longer in axile and basal parts, but often scarcely larger toward the growing apices: monoicous: antheridia in groups of 2–4: involucres often numerous and crowded, but very rarely with the bases united in pairs, subfusiform or narrowly cylindrical, often curved, 2–9 × .35–1.2 mm., smooth, furrowed, or rarely lamellate, mouth repand or scarious and erose-lacerate: capsule dusky brown to black, 2–9 cm. (mostly 3–6 cm.) × .25–.5 mm., rather long-pedicellate, valves commonly a little twisted on drying, stomata abundant, the guard-cells nearly colorless; spores dark brown or black, 45–63 μ in maximum diameter, angular, the convex face with very numerous (125–225) spines or papillae less than 3 μ in length, plane faces granulose-papillate or sinuate-foveolate; pseudo-elaters fuscous, 60–250 × 8–14 μ, of 1–4 cells, geniculate and variously contorted, sometimes branched.

EXSICC. Hep. Am. 163.

On moist banks. Common on the Pacific coast from southern California to British Columbia.

A. fusiformis is a close ally of *A. punctatus*, differing in the larger, thicker, more dissected, and usually more lamellate-cristate thallus, the rarely geminate, often longer involucres, the longer capsules, the rather larger, more minutely and thickly echinulate or papillate spores, and in the longer, narrower elaters. In the southern part of California it makes its nearest approach to *A. punctatus*, but may be distinguished from that species after a little experience by the characters of the spores and elaters. The involucres in the Californian plants are rarely more than 5 mm. long. *A. fusiformis* ripens its spores in California in April and May, at which time the thallus has commonly become shriveled and inconspicuous.

Following Austin's original description of *Anthoceros fusiformis* three specimens are cited, as follows: "Observation [Observatory] Inlet, Columbia, Dr. Scouler in Herb. Torrey; also in Herb. Taylor. California, Bolander. Oregon, E. Hall." What appear to be these three originals are preserved in Herb. Pearson. Hall's specimen is marked "R. Mts., Hall," but this manner of giving the habitat of Hall's Oregon Hepaticae is observed elsewhere in the Austin collection.

ANTHOCEROS FUSIFORMIS STOMATIFER (Aust.).

Anthoceros stomatifer Aust. Bull. Torr. Bot. Club, 6: 28. 1875.

Capsule slender, 4–9 cm. × .25–.4 mm., black, the valves much twisted in drying; spines of the spores sometimes exceeding 3 μ in length; pseudo-elaters rather broader.

Oregon and northward.

A. fusiformis stomatifer is, in some respects, intermediate between *A. fusiformis* and *A. punctatus*. It seems to have nothing in thallus, involucre, or number of stomata on the capsule-wall, to distinguish it from *A. fusiformis;* and is scarcely distinguishable from *A. punctatus* except by the longer, narrower involucre, the longer capsule, more twisted valves, and the rather larger spores with much more abundant spines. Intergrades perfectly with the genuine *A. fusiformis*. The probable type of *A. stomatifer* Aust., marked "Rocky Mts., Hall" is in Herb. Pearson.

9. ANTHOCEROS RAVENELII Aust. Bull. Torr. Bot. Club, 6: 28. 1875.

Anthoceros Lescurii Aust. *l. c.* 6: 28.

Anthoceros Joorii Aust. *l. c.* 6: 29.

Anthoceros Olneyi Aust. *l. c.* 6: 29.

Thallus suborbicular, 6–16 mm. broad, light green, blackening with age, more or less rugose and foveolate, sometimes verrucose-punctate and lamellate, laciniate or subradiately dissected, with oblong-flabelliform, crenate or variously lobed, occasionally suberect segments, 8–15 cells thick in axile parts, 3-stratose at margin, with internal lacunae; surface-cells somewhat distinct, subquadrate, oblong, or pentagonal, 25–50 × 18–30 μ, with rather small chloroplast: monoicous: involucres frequently geminate, short-cylindrical, .8–2.5 × .4–1 mm., smooth or lightly striate, usually a little dilated toward the truncate, crenate or repand-dentate, often narrowly scarious mouth: capsule fuscous, clavate-cylindrical, 8–20 × .3–.8 mm., thick-walled, with numerous stomata, the valves slightly flexuous; columella often at first strongly appendiculate, becoming naked; spores scarcely angled, black or fuscous, 70–100 μ in maximum diameter, covered throughout with very numerous short blunt papillae, these sometimes confluent into vermicular anastomosing lines; sterile cells dusky brown, ellipsoidal, globose, or subcubical, usually shriveled, mostly separate but sometimes forming catenulate groups or variously adherent.

On moist earth. South Carolina (Ravenel, Austin); Florida (Chapman, Austin); Alabama (Mohr); Louisiana (Joor, *fide* Austin, Langlois, no. 395, *p. p.*).

Type in Herb. Pearson; duplicate in Herb. Columbia University.

The spores in *A. Ravenelii* show considerable variation in their markings, from anastomose-reticulate ridges to separate papillae, but we have observed quite wide extremes in respect to this character even in different parts of a single capsule. Yet the papillae are less commonly reduced to reticulate lines in the Louisiana and Alabama specimens than in those from South Carolina and Florida.

Anthoceros Lescurii and *A. Joorii* were retracted by Austin himself four years after their proposal,* these being considered mature conditions of *A. Ravenelii*, which was originally described from immature material. In *A. Olneyi* Aust., the erectness of the frond appears in all the specimens we have seen to be due largely to the way the plant is glued and pressed to the mounting paper. The "large, black, globular, tuberculated granules just beneath the surface of the frond," for which *A. Olneyi* is chiefly remarkable, are spore-masses or possibly undeveloped perithecia belonging to a peculiar endophytic fungus. The thallus is permeated with colorless or light-brown septate hyphae at the ends of lateral branches of which are formed globular clusters, 25–45 μ in diameter, each composed of numerous dark, smoothed-walled cells, measuring 6–10 μ. The fungus bears some superficial resemblance to certain of the Tilletiaceae. The same parasite occurs also in specimens of *A. Ravenelii* from Mobile, Ala. (Mohr), and, occasionally also, the same or a very similar one in *A. Hallii* from Seattle, Washington (Hep. Am. 162).

10. ANTHOCEROS MACOUNII sp. nov.

Thallus forming small dark green rosettes, 4–10 mm., in diameter, strongly undulate-crisped, subradiately inciso-laciniate or somewhat broadly lobed, rugose, pitted, sometimes slightly lamellate, ecostate, 6–8 cells thick in axile parts, cavernose, becoming at the margin gradually 3- or 2-stratose, now and then glandular-thickened; surface-cells distinct, translucent, lightly protuberant, subrhombic, trapezoidal, or oblong-pentagonal, 35–75 × 30–35 μ; *Nostoc* colonies spherical: monoicous: antheridia in groups of 3 or 4: involucres short, sometimes united in pairs, cylindrical-oblong, or by contraction at base and mouth, dolioform or subglobose, .85–1.25 × .5–.9 mm., incrassate except at the thin erose or subentire mouth: capsule black, erect or a little curved, 3–6 × .3–.5 mm., thick-walled, with numerous stomata, the valves rigid or slightly flexuous when dry, brittle and often broken; columella sometimes appendiculate; spores fuscous or black, rounded-tetrahedral, densely and rather minutely muriculate on both the inner and outer faces, 48–65 μ in maximum diameter; sterile cells short, nearly as broad as long, without spiral thickenings, separate or variously adherent, often shriveled and inconspicuous. (Plate 326.)

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* Bull. Torr. Bot. Club, 6: 305. 1879.

EXSICC. Can. Hep. 81 (as *A. punctatus*).

"Abundant on earth subject to inundation at the outlet of Leamy's Lake, near Hull, Quebec, 6th October, 1889" (Macoun).

Anthoceros Macounii is allied to *A. Ravenelii* Aust., from which it is clearly distinct in the shorter capsule, in the much smaller, more angular spores, with the short papillae mostly separate, never (in the specimens seen), passing into vermicular anastomosing lines, and in the more fragmentary, less abundant sterile cells. Distinguished at once from *A. punctatus* by the short capsules, the mostly larger, merely muriculate, not echinulate or setose-papillate spores, and by the reduced abortive sterile cells; the spores, too, in *A. Macounii* are almost uniformly roughened over the entire surface, while in *A. punctatus* the inner faces of the spores are nearly always simply foveolate-reticulate.

NOTOTHYLAS Sulliv. Musc. Allegh. [Exsicc.] nos. 289 and 290, with diagnosis. 1845. Id. [Reprint of tickets] 69. 1846.

[CARPOBOLUS Schwein. Jour. Philad. Acad. 2: 361. 1822. Not Adans. Fam. 2: 8. 1763.]

[CARPOLIPUM Nees, G. L. N. Syn. Hep., 591. 1846.]

Thallus orbicular, laciniate, or with broad, rounded, crenulate-incised lobes, ecostate, of more than one layer of cells throughout.

Monoicous. Sporogonia chiefly marginal, but becoming now and then dorsal, wholly or for the greater part enclosed within the involucre, suberect or horizontal-deflexed. Capsule short, oblong-sphaeroidal to elongate-cylindrical, bivalved or opening irregularly, without stomata; columella sometimes early disintegrated and obscure; spores often nearly smooth; sterile cells single or irregularly adherent, hyaline, nearly cubical, usually with traces of spiral thickenings.

Key to the Species.

Spores smooth or nearly so.	1. *N. orbicularis.*
Spores muriculate, at maturity fuscous or nearly black.	2. *N. Breutelii.*

1. NOTOTHYLAS ORBICULARIS (Schwein.) Sulliv. Musc. Allegh. [Exsicc.] subjoined to no. 290. 1845.

Targionia orbicularis Schwein. Spec. Fl. Am. Sept. Crypt. 23. 1821.

Carpobolus orbicularis Schwein. Jour. Philad. Acad. 2 : 370. *pl., f. II.* 1822.

Notothylas valvata Sulliv. Musc. Allegh. [Exsicc.] 289. 1845.

Notothylas melanospora Sulliv. l.c. 290.

Thallus forming flat, often confluent rosettes 5–16 mm. in diameter, deeply lobed, undulate-crisped, often with narrow ascending marginal laciniae, ridged and pitted but scarcely lamellate, 4–8 (rarely 12) cells thick in axile parts, with large lacunae, becoming sometimes widely 3- or 2-stratose toward the margin; surface-cells distinct, protuberant, quadrate, rhombic, or oblong-hexagonal, 40–145 × 30–40 μ: involucres commonly at the marginal sinuses, becoming sometimes distinctly dorsal, often geminate, corniform, horizontal-deflexed, more rarely suberect: capsule widening a little below the middle, ovate- or oblong-cylindrical, occasionally oblong-ovoid, .75–3.25 × .35–.65 mm., with or without distinct lateral sutures, bivalved or opening irregularly, the exterior cells oblong or irregularly quadrate, usually very thick-walled, those bordering the valves yellowish-brown and more solid; columella often fuscous and appendiculate; spores rounded-tetrahedral, 36–50 μ in maximum diameter, yellow, becoming at times nearly black, smooth or very obscurely roughened on the convex face; sterile cells difform, mostly single and subcubical, with rudiments of spiral thickenings.

EXSICC. Musc. Allegh. 289, 290; Hep. Bor-Am. 124, 125; Hep. Am. 65.

On moist soil. North Carolina (Schweinitz); Virginia (Underwood); Delaware (Commons); Pennsylvania (James); New Jersey (Austin); Connecticut (Underwood); Massachusetts (Underwood and Seymour); Ohio (Sullivant, Lesquereux); Indiana (Underwood).

Type in Herb. Schweinitz in possession of the Philadelphia Academy of Natural Sciences.

The color and size of the spores and the appendiculate columella—characters which were emphasized by Sullivant in distinguishing *Notothylas melanospora* and *N. valvata*, are seen from a study of the specimens now accessible to afford little or no basis for a specific separation. Of greater constancy, perhaps, in comparing the forms that we have included under *N. orbicularis*, are the length of the capsule, the texture of its outer wall, and the presence or absence of sutures, yet these, we believe, are matters of vigor and perfection in development rather than of specific significance. Capsules that project well beyond the involucre seem invariably to exhibit well defined sutures and to have very thick-walled, usually oblong, cells on the surface, while those that ripen wholly enclosed in the involucre, on the same plant, sometimes, have only rudimentary sutures or none at all and show comparatively thin-walled, often irregularly quadrate, surface-cells. Sullivant seems to have proposed *N. melanospora* with some hesitation, and Spruce* has placed on record his doubt as to its distinctness. *N. valvata* Sulliv., as is well known to American hepaticologists, was first reduced by Austin. The spores in *N. orbicularis* occasionally undergo quite a remarkable change of color in the ripening, being sometimes almost black in the upper part of the capsule while bright yellow below. The change appears to be quite different in nature from that in *Anthoceros punctatus* and its allies, in which there is in the earlier stages no yellow but a dusky tinge, this being simply intensified in the process of maturing.

2. NOTOTHYLAS BREUTELII (Gottsche) Gottsche Bot. Zeit. 16: 21 (Anhang). 1858.

Anthoceros Breutelii Gottsche, G. L. N. Syn. Hep. 583. 1846.

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* Hepaticae of the Amazon and Andes, 578. 1885.

Thallus rosettes mostly broad and flat, 10–20 mm. in diameter, reticulate or nearly smooth, 4 or 5 cells thick in median parts, with lacunae, but chiefly 3- or 2-stratose, subradiately cleft, the lobes commonly broad, rounded, denticulate or slightly crenulate-incised at margin; surface-cells irregular and indistinct: involucres corniform, marginal or often becoming widely dorsal, horizontal or ascending: capsules ovate- or oblong-cylindrical, 1.5–3 mm. long, bivalved, the exterior cells thick-walled, those bordering the valves yellowish-brown; columella early disintegrated; spores at first yellow, becoming fuscous or nearly black at maturity, 36–48 μ in maximum diameter, muriculate on the convex face.

In an old ditch, Pointe à la Hache, Louisiana, (Rev. A. B. Langlois, no. 85).

The thallus in the Louisiana plant is rather broader and less incised than in a Cuban specimen collected by Wright and said to have been determined by Gottsche, but the agreement in characters of capsule and spores is very close. It may be remarked that the spores of *N. orbicularis* are sometimes obscurely tuberculate or papillate on the convex face, but this roughening in *N. Breutelii* is much more pronounced.

Explanation of Plates.

Plate 321. *Anthoceros Carolinianus occidentalis* M. A. Howe.

1 and 2. Portions of the thallus, natural size.

3–5. Involucres, × 12.

6. Segment of thallus with marginal glandular-thickening, × 6.

7. Transverse section of thallus segment (showing but one-half the width), × 23.

8. Spores, × 305.

9. Pseudo-elaters, × 225

All drawn from specimens collected in California; Figs. 1–3, 8 and 9, Olema, Marin Co. (Mr. W. L. Jepson); 4 and 6, Twin Oaks, San Diego Co. (Mr. F. W. Koch); 5, Howell Mountain, Napa Co. (Prof. W. A. Setchell); 7, Mt. Tamalpais, Marin Co.

Plates 322 and 323. *Anthoceros Pearsoni* M. A. Howe.

1. Segment of the thallus, with mature sporogonia, natural size.

2, 3 and 4. Portions of a sterile thallus, showing its form, manner of branching and the beginnings of the marginal glandular-thickenings, natural size.

5. Marginal glandular-thickenings, fully developed, × 12.

6 and 7. Thallus segments with younger, sometimes peduncled, glandular-thickenings, × 12.

8. Ventral view, showing glandular-thickening bearing root-hairs, × 12.

9 and 10. Longitudinal sections through well developed glandular-thickenings, the latter exhibiting embedded antheridia, × 53.

11. Transverse section of margin of the thallus, × 53.

12. Median longitudinal section of the thallus, × 53.

13–15. Involucres, × 12.

16. Pseudo-elaters, × 225.

17. Spores, × 305.

All figures of *A. Pearsoni* from Californian material; 1, 13, 16 and 17, Mill Valley, Marin Co. (the type); 2–4, near Duncan's Mills, Sonoma Co. (no. 1200) 5, 9, 10, 14 and 15, near Mendocino (no. 702); 6 and 7, Cazadero, Sonoma Co. (no. 1199); 8, Palo Alto (Prof. D. H. Campbell); 11 and 12, Mill Valley, Feb. 22, 1896.

Plates 324 and 325. *Anthoceros phymatodes* M. A. Howe.

1. Portion of the thallus, natural size.

2. Ventral view of a thallus segment, showing costa and tuber, × 23.

3–6. Lateral views of thallus segments, showing form and stages of development of tubers, × 23.

7 and 8. Old tubers, showing vegetative propagation by sprouting, × 23.

9. Longitudinal section through costa and young tuber, × 47.

10. Longitudinal section showing early stages in the formation of the tuber, × 47. The section is somewhat oblique and does not exhibit the full thickness of the costa.

11. Section through a well-grown tuber, × 53.

12. A single interior cell from fig. 11, × 305.

13. Longitudinal section through the costa, × 53.

14 and 15. Transverse sections of thallus segments, × 53.

16. Outlines of two other transverse sections of thallus segments, × 23.

17. Involucres, × 12.

Figs. 1–6 and 9–17 from specimen collected in Mill Valley, Marin Co, California. February 22, 1896—mostly drawn from material fixed with 1% chromic acid and preserved in alcohol; 7 and 8, from same locality, March 19, 1892.

18. Involucre of *Anthoceros polymorphus* Raddi, γ *dichotomus* Raddi, ex herb. Raddi, × 12.

Plate 326. *Anthoceros Macounii* M. A. Howe.

1. Portion of thallus with involucres and sporogonia, × 12.

2. Capsules after dehiscence, × 12.

3. Involucres, × 12. The capsules of *A. Macounii* appear to be very brittle; in this fragment they were found broken off at the mouth of the involucres as indicated in the figure.

4. Involucre and capsule with a broken valve, × 12.

5. and 6. Involucres and broken capsules, × 12.

7. Stoma from surface of capsule, × 305.

8. Columella, × 53.

9. Spores and pseudo-elaters, × 305.

All the above figures from Can. Hep 81.

10. Spores of *Anthoceros punctatus* L. from Hep. Bor-Am. 122, × 305. Introduced for comparison.

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